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TURBULENT FLIGHT - PART 2

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Publisher: Airbus Industrie Customer Services, 1 rond-point Maurice Bellonte, 31707 Blagnac Cedex, France
Telephone: +33 61 93 33 33, Telex AIRBU 530526F, Telefax +33 61 30 01 25
Editor: Denis Dempsey, Product Marketing
Graphic design: Agnès Lacombe, Customer Services Marketing
Photo-engraving: Image Photographie, 18 rue Tivoli, 31000 Toulouse, France
Printer: Escourbiac, 5 Av Marcel Dassault, 31502 Toulouse Cedex, France

This issue of FAST has been printed on paper produced without using chlorine, to reduce waste and help to conserve natural resources. ‘Every little helps’.
Airbus Industrie, in association with its Spanish member CASA, has developed a new impossible water ingress infrared thermography. So successful has the technique proved, that Airbus Industrie is now recommending that all operators of its aircraft adopt this method as the standard inspection measure for such parts. The process described applies particularly to elevators on the Airbus range of widebody aircraft. It is applicable for use on similar composite sandwich structures, however the temperatures and times would vary depending on their construction parameters.
The risk of water ingress in sandwich composite type structures has long been known to aircraft manufacturers. A typical sandwich composite structure is shown in Figure 1. Water ingress can occur in such structures if the sealing between the inside and outside of the cell is lost, allowing moisture to accumulate inside it. Left unchecked, this would eventually affect the structural integrity of the part.

Until Airbus Industrie started to consider how operators might better inspect its aircraft, there was only one method qualified for detecting water in sandwich structures: namely X-ray inspection.

With composite sandwich structures, however, the X-ray technique does not work well, because more than one layer is usually involved. With the photographic film and X-ray source invariably having to be placed on either side of the structure, this means that, if water is found, there is no way of knowing in which of the two sandwich layers it occurs (Figure 2). Disassembly of the component would be impractical. Hence the interest in thermographic inspection as an alternative solution.

Infrared thermography works on the principle that all objects emit electromagnetic radiation in proportion to their temperature. Using an infrared camera which converts incident thermal radiation into an electronic signal which can subsequently be displayed on a video screen, it is possible to study the distribution of temperature across the surface of an object.

It soon became apparent that the technique could easily be applied to the detection of water ingress because of the difference in specific heat capacity, density and thermal conductivity for both water and composite materials. Since the specific heat of water is approximately five times greater than composite materials, this would mean that any changes in temperature would be much slower in a zone contaminated by water.

In order to be able to carry out a thermographic inspection of such a composite structure, it was therefore necessary to create a situation where the object was out of thermal equilibrium and a heat flow would have to be created to return the structure to equilibrium.

**Figure 1**
Typical honeycomb sandwich structure
A number of options were available to achieve this. The most obvious one was to inspect the structure immediately after landing, watching it as it warms up after a long period of being cooled in the air. However, this idea proved to be unreliable as it was difficult to control the time period prior to inspection, due to changing factors such as the descent profile, holding and taxiing. It was also shown to be greatly influenced by the external ground temperature.

The other alternative was to artificially excite the structure so that it behaved as a thermally active object. The options were to cool the structure down so that any water present would freeze, or heat it up to a predetermined temperature and inspect it as it cools down. Due to the relatively large size of sandwich parts, which may be several metres long, the first option was not really practical as a maintenance technique. Whilst the second option is much better, it does require careful attention to make sure that any heat damage to the structure is avoided.

Having established the basis for a technique for inspecting water ingress the next step was to set about refining the test and choosing an infrared camera which provided the right combination of features for this test. The ThermoVision 210 camera was chosen and, with a thermal resolution of 0.1° Celsius at 300°C, it clearly offered the right level of sensitivity required for detecting even the smallest amounts of water. Indeed, it proved able to detect an area of water ingress measuring only 120mm² (0.2in²) contaminated with 10% of water in the cells where the water was not in contact with the external skin panel actually being photographed, as illustrated in Figure 3.

Weighing only 1.6kg and scarcely larger than a 35mm camera, it is easily carried and allows an inspection engineer to move the camera to other parts of the structure with ease. With only six basic controls located ergonomically at the back of the camera, it is also very easy to use and does not require lengthy training to instruct prospective inspection engineers in its use. It is safe to use and not subject to the safety restrictions typical of X-ray inspection techniques.

**THE TEST PROCEDURE**

Having chosen the basic inspection tool, then began the definition of the rules within which a proper thermographic inspection should be carried out.

Since infrared cameras will detect all manner of external radiation, it was essential to make sure that the inspection was carried out in an area where no other thermal radiation sources existed. Inspection was consequently recommended to be carried out in a place where the

---

**Figure 3**

Water not in contact with external skin is easy to detect

---

**Figure 4**

Electric blanket laid out on the upper surface of an elevator
ambient temperature could be kept between 5°C and 40°C.

To avoid causing any damage to the structure, it was concluded that the structure should be heated up to about 50°C over the ambient temperature and the time taken to reach this temperature should not be less than twenty minutes, with the last ten minutes being held at this temperature. Certainly, no part of the structure should achieve a temperature of more than 90°C. Heating is achieved using an electric blanket (Figure 4) linked via thermocouples to a temperature control unit (Figure 5). Figure 6 shows how the electric blanket can be held on to a structure which is not horizontal and may be inverted.

Airbus Industrie found that the best results were obtained when inspection was carried out twenty minutes after the heating blanket had been removed, allowing enough time for temperatures to equalise across the surface of the structure. They also found that consistent results could not be maintained if the subsequent inspection took any longer than ten minutes.

When it came to inspecting the structure, it was determined that the angle of observation was important in producing the best results from a thermographic survey. Indeed, two surfaces with equal emissivity and equal temperature could produce different thermal images depending on the angle of observation. An angle of incidence as close as possible to 90° has therefore been specified. The best results are achieved when the camera is held at a distance between one and two metres from the structure.
Two people are required to carry out an inspection: one to perform the scanning of the inspection area and the second to mark on the surface of the structure those water-trapped areas indicated as hot spots on a video monitor linked to the camera. Figure 7 shows one person viewing the structure through the infrared camera and another marking out the location of hot spots on the structure by following the thermal image displayed on the hand-held video monitor.

Using the inverted display mode on the camera, the presence of water was indicated by darker (hotter) areas compared to the surrounding area. Contrast and brightness adjustments on the camera ensured the best image for detecting small hot spots.

Having defined the basic test criteria, experience enabled the operators to quickly differentiate between hot spots caused by water ingress, and hot spots caused by other structural components such as hoisting points, inserts, ribs, holes and existing repairs. Figure 8 shows the location of two hot spots caused by water ingress and another caused by a fastener. A criteria of damage acceptance was established—limits to the size of hotspots, above which a structure was rejected and below which the amount of water present was acceptable. This criteria was based not only on the size of a particular hot spot but also the location and size of neighbouring hot spots within a given radius. Figure 9 shows the surface of a structure which has been marked up during a thermographic survey.

**CONCLUSION**

The new technique has proved very reliable. The first official inspection was carried out in July 1993 and this technique is now the standard procedure for the inspection of composite sandwich structures and is included in the Non-Destructive Testing Manual. Although thermography is relatively new as a non-destructive testing tool in the aircraft industry, it has proved extremely successful in this application and will certainly find other applications in the near future. Aided by the simplicity of an inexpensive thermal imaging camera, the technique is very easy to apply, provides immediate results and requires no specific safety precautions.
A turbulence encounter is a play featuring three characters:
the atmosphere,
the aircraft and the pilot
(whether a human pilot or an auto-pilot).
The purpose of this article is to review the respective role and contribution of these three actors, through the main aspects associated with flying in severe turbulence at altitude.

Most of the considerations addressed in this article are general in nature and are equally applicable to the A300/A310/A300-600 and to the A320/A330/A340 aircraft families.

Whenever applicable, specific considerations are given for non-fly-by-wire and fly-by-wire models respectively.
TURBULENCE ENCOUNTERS AND AVIATION SAFETY

Severe turbulence encounters at altitude have been experienced worldwide by all models of jet transports, sometimes resulting in injuries to passengers and cabin attendants.

The statistical data related to turbulence encounters reveal that narrowbody and widebody aircraft of all types and models are equally affected. A survey performed by the US FAA and the Flight Safety Foundation revealed that turbulence causes twice as many serious injuries to passengers and cabin attendants as does emergency evacuations.

The particular nature of flight in severe turbulence and its possible consequences, in terms of passengers or crew injuries and/or aircraft damage, should not be underestimated and should be highlighted whenever and wherever applicable.

DEFINING SEVERE TURBULENCE

Considerations and procedures related to flight in severe turbulence are applicable only when such severe or very severe turbulence conditions are encountered. ICAO defines the turbulence severity as a function of the vertical acceleration at the aircraft centre of gravity and as a function of the turbulence effect on the aircraft flight, as defined in Table 1.

Severe turbulence is sometimes defined as a turbulence level which impairs reading of the cockpit instruments and/or gauges. A combination of criteria based on years of flying experience undoubtedly constitutes the best blend for defining severe or very severe turbulence conditions.

An exhaustive overview of all the possible causes of turbulence would exceed the scope and size of this FAST magazine. The interested reader may refer to the numerous books available in aviation book shops. One of these publications provides a comprehensive and truly pilot-oriented review of this subject, "TURBULENCE - A New Perspective For Pilots" by Peter F. Lester (Jeppesen Sanderson Training Systems).

Table 1: Defining the level of turbulence

<table>
<thead>
<tr>
<th>Turbulence severity</th>
<th>Vertical acceleration ((\gamma))</th>
<th>Effect on flight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low</td>
<td>(\gamma \leq 0.05) g</td>
<td>Light oscillations in pitch and roll</td>
</tr>
<tr>
<td>Low</td>
<td>(0.05 \leq \gamma \leq 0.2) g</td>
<td>Marked frequent oscillations : ride comfort affected.</td>
</tr>
<tr>
<td>Moderate</td>
<td>(0.2 \leq \gamma \leq 0.5) g</td>
<td>Strong intermittent jolts.</td>
</tr>
<tr>
<td>Severe</td>
<td>(0.5 \leq \gamma \leq 1.5) g</td>
<td>Aircraft handling affected.</td>
</tr>
<tr>
<td>Very severe</td>
<td>(\gamma &gt; 1.5) g</td>
<td>Unacceptable for passengers' comfort.</td>
</tr>
</tbody>
</table>

Table 2: Forecasting turbulence

<table>
<thead>
<tr>
<th>Type of turbulence</th>
<th>Remarks - Forecasting tips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convective storm cells</td>
<td>Clear Air Turbulence (CAT) may be expected close to convective storm cells.</td>
</tr>
<tr>
<td>Frontal surfaces</td>
<td>Severe turbulence may be expected due to friction of air masses and due to horizontal windshear caused by wind component change across the frontal surface.</td>
</tr>
<tr>
<td>Orographic waves</td>
<td>Turbulence may exist even in the absence of lenticular clouds.</td>
</tr>
</tbody>
</table>
| Dynamic gravity waves       | CAT may be anticipated whenever one or more of the following conditions are met :  
  - vertical wind gradient (rate of change or Shear Rate) > 5kt / 1000ft (Table 3),  
  - horizontal wind gradient > 40kt / 100nm,  
  - horizontal OAT gradient > 4°C / 100nm,  
  - route is close to the polar side of a jetstream (Figure 1),  
  - route is close to an altitude trough of low pressure.  
  Exiting CAT :  
  - if TAT/SAT increase → climb,  
  - if TAT/SAT decrease → descend. |
| Jetstreams                  | Severe turbulence may be expected, if jetstream exceeds 100kt, on its polar side (Figure 1). |
Forecasting turbulence

The likelihood of encountering severe turbulence during a given flight can be assessed using the data contained in the standard weather briefing, using the criteria and tips provided in Table 2 and Figure 1.

For Clear Air Turbulence (CAT) due to vertical and/or horizontal wind gradient, the US National Oceanic and Atmospheric Administration (NOAA) has analyzed wind patterns associated with jetstreams around the globe and has defined a Turbulence Index which allows maps of likely areas of CAT to be established.

Some Computerized Flight Plans (CFP) provide a simple index at each waypoint, referred to as the Shear Rate (SR), expressed in kt/1000ft, as illustrated in Table 3. This index represents the vertical wind gradient and constitutes a dependable turbulence indicator.

Moderate turbulence can be expected whenever the Shear Rate is equal to or greater than 3. Severe turbulence can be anticipated whenever the Shear Rate is equal to or greater than 5.

However, it is a fact of life that severe turbulence may be experienced unexpectedly and suddenly during the course of an otherwise smooth ride, despite the sophisticated forecasting techniques available.

In readiness, turbulence anticipated or not, operational recommendations and procedures are published for:

- Flight in severe turbulence: turbulence penetration preventing exceedance of maximum operating speeds (Vmo/Max)

Table 3

<table>
<thead>
<tr>
<th>Computerized Flight Plan (CFP) - Shear Rate (SR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSN</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>N24</td>
</tr>
<tr>
<td>WATER</td>
</tr>
<tr>
<td>106</td>
</tr>
</tbody>
</table>

- recovery from a turbulence upset: recovery from Vmo / Mmo exceedance.

How does turbulence upset the aircraft?

Whether the turbulence is caused by a vertical or a horizontal gust, the gust results in a change in the g-load factor and, usually, in a pitch and airspeed upset. The aircraft design speeds and structure are defined to account for the above overload and overspeed conditions resulting from a defined gust being experienced at the aircraft cruise design speed.

The analysis of events' data related to Airbus and non-Airbus aircraft, reveals the following possible variations as a result of a turbulence upset:

- **Vertical gust:**
  - 2,000 to +4,000 fit/min,
  - Vertical acceleration: -0.8 to +2.8g,

- **Horizontal gust** (windshear):
  - 20 m/s, 40kt,
  - Indicated airspeed variation: 20 to 40kt,
  - Mach number variation: 0.03 to 0.05.
In turbulent conditions, the aircraft is naturally stable. This natural stability is further enhanced by the auto-pilot (AP) control laws. The AP has a built-in ability to cope with turbulence upset and, therefore, should be kept engaged (unless the AP action is considered to be unsatisfactory or leads to marked speed excursions) and should not be overridden during turbulence.

Figure 2 provides the synopsis of a typical sudden turbulence encounter, experienced during cruise on an A310 aircraft. Analyzing this event phase by phase provides an appreciation of the role of the three actors at play, the atmosphere, the aircraft and the pilot, throughout the encounter.

The flight data have been retrieved from the Digital Flight Data Recorder (DFDR). The vertical gust values have been derived by computation from the following data:
- true Angle of Attack (AoA), assessed by correction of local AoA data,
- pitch attitude,
- flight path angle relative to the ground, based on altitude history.

The initial conditions were as follows:
- flight level 350 (35,000ft),
- AP engaged in Command mode (CMD),
- Flight Management System (FMS) engaged in PROFILE and Navigation (NAV) modes,
- Mach 0.82,
- very low turbulence level (γ < 0.05 g).

This synopsis is typical and consistent with the analysis of many similar turbulence encounters. It clearly illustrates and explains the following aspects:
- the flight crew's manual pull-up order, leading to the AP disconnection, is a conceivable instinctive response to the perception of the sinking tendency as well as the overspeed condition;
- the large g-load factor variations are the result of the vertical gust effect and/or of the manual elevator orders, but are not the result of the AP activity in reaction to the gust.

**Figure 2**
Synopsis of a typical turbulence encounter
The aircraft response to turbulence upset is a function of its aerodynamic and systems' design.

On the A310 and A300-600 the AP design objectives, in speed/altitude hold (SPD/ALT HLD) modes, are to maintain the selected targets as follows:
- speed: by immediate thrust variations,
- altitude: by pitch variations, with a vertical acceleration authority not exceeding ±0.2g.

The FMS design objectives, in PROFILE/NAV modes, are to maintain the speed and altitude targets with a reduced authority to maximize the passenger’s comfort.

On the Honeywell FMS, this reduced authority is achieved as follows:
- speed: "soft speed" concept for reduced auto-throttle activity,
- altitude: pitch variations, with a vertical acceleration not exceeding ±0.05g.

On the Smiths FMS, a "soft altitude" concept fulfills the same objectives.

The Flight Augmentation Computer (FAC) and the Flight Control Computer (FCC) are the brain and heart of the aircraft system’s response to turbulence. Several changes summarized in Table 4 have been incorporated in the FAC to prevent the disconnection of the pitch trims and yaw dampers (and consequently of the auto-pilot) in turbulence, and to enhance the aircraft’s response to

| Table 4 |
|---------------------|-----------------|-----------------|
| Enhancement of FAC laws | A310         | A300-600       |
| Increased acquisition rate for yaw rate and AoA data | P/N B352AAM3  | P/N B471AAM32  |
|                     | Modification 7258 | Modification 7720 |
|                     | Airbus SB 22-2023 | Airbus SB 22-6012 |
| Enhanced yaw behaviour (Fish tailing) | Not applicable to A310 | P/N B471AAM3  |
|                     |                | Modification 8020 |
|                     |                | Airbus SB 22-6013 |
| Improved α-trim law | P/N B471ABM3  | P/N B471AAM5   |
|                     | Modification 8364 | Modification 8834 |
|                     | Airbus SB 22-2032 | Airbus SB 22-6014 |

Analysis phase by phase

**Phase 1**
- A first vertical gust is met (downdraft) which progressively reaches -700ft/min.
- The angle of attack and the g-load factor decrease in response to the downdraft.
- The pitch attitude remains unchanged.
- No AP activity is observed. This conforms to the AP control law design which responds only to pitch or altitude variations.

**Phase 2**
- A second vertical gust (updraft) builds up, within one second, up to +2,000 ft/min.
- This updraft results in an immediate increase of the angle of attack and, correspondingly, of the g-load factor.
- The pitch attitude starts to increase.
- A horizontal gust (horizontal wind-shear) associated with the large updraft leads to an MMO exceedance (Mach increases up to 0.85).

**Phase 3**
- The updraft starts to decay resulting in a corresponding decay of the angle of attack and g-load factor.
- The AP activity (elevator "aircraft nose down" order) is consistent with the pitch attitude increase (and the associated 100ft gain relative to the initial attitude).

**Phase 4**
- The updraft further settles. Perceiving the aircraft to be "sinking" as well as the overspeed condition, the pilot applies (quite understandably) a "nose up" elevator order. However, the corresponding force on the control column exceeds the preset threshold and results in the AP disconnection.
- As a result of the manual "nose up" elevator input, the pitch attitude, the angle of attack and - correspondingly - the g-load factor increase again.
- The pitch attitude continuing increase is counteracted by the horizontal stabilizer "aircraft nose down" deflection (angle of attack protection, known as the α-trim function).

**Phase 5**
- The updraft completely settles and turns into a downdraft reaching -1,600 ft/min.
- The angle of attack and g-load factor decrease in response to the downdraft.
- Under the combined effect of the downdraft and the "aircraft nose down" trimming (α-trim) the g-load factor reaches temporarily 0 g.
- The AP is re-engaged, although the flight parameters are still significantly affected.

**Phase 6**
- The elevator order and horizontal stabilizer deflection return to normal values, while the downdraft starts to settle.

**Phase 7**
- The turbulence encounter is over, all flight parameters return to stabilized values.
Table 5
Enhancement of FCC laws

<table>
<thead>
<tr>
<th></th>
<th>A310</th>
<th>A300-600</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALT HLD mode</td>
<td>P/N B470ABM2</td>
<td>P/N B470ABM2</td>
</tr>
<tr>
<td>and AP connection</td>
<td>Modification 10402</td>
<td>Modification 10403</td>
</tr>
<tr>
<td>time delay</td>
<td>Airbus SB 22-2036</td>
<td>Airbus SB 22-6021</td>
</tr>
</tbody>
</table>

and recovery from a turbulence upset. After incorporating these changes, no AP disconnection in turbulence has been observed, except those resulting from a force being applied by the flight crew on the control column.

The response of the AP in turbulence has been also enhanced by increasing the rate of the altitude recovery in ALT HLD mode and by adding a time delay for the AP disconnection by force on the control column. These improvements have been incorporated in the most recent FCC standard (Table 5).

On the A320 and subsequent fly-by-wire (FBW) models, the in-service experience has confirmed how well the FBW philosophy is ideally suited to enhance the aircraft behaviour in turbulent conditions. The benefit of FBW is particularly visible in manual flight in "stick neutral" condition. The characteristics of the FBW control laws (in terms of response time and rate) are such that the aircraft will stabilize quite rapidly whereas a conventional aircraft would oscillate in the same conditions.

**Flight crew procedures**

The procedures for Flight in Severe Turbulence published in the Procedures and Techniques chapter of the FCOM for the A300/A310/A300-600 aircraft, Supplementary Techniques chapter for the A320/A321/A330/A340 aircraft are consistent for all aircraft models regarding the following recommendations:

- disconnect auto-throttle (A/THR) to prevent auto-throttle activity,
- keep AP engaged.

On the A310 and A300-600, the AP should be kept in CMD but a manual reversion should be made from PROFILE to ALT HLD in cruise, or Level Change (LVL CH) in climb or descent, to take benefit of the full AP authority. This latter recommendation should be considered not only upon entering a turbulent area but also as a preventive action whenever there is evidence that severe turbulence is likely to be encountered.

Using the AP in SPD/ALT HLD modes, instead of PROFILE, will also help to prevent the occurrence of a VM0 / Mmo exceedence condition.

The Control Wheel Steering (CWS) mode should not be used. Because of the light stick forces, resulting from the absence of artificial feel and pitch feedback in this mode, and of the availability of the auto-trim (the CWS mode being an AP mode), the CWS mode is very sensitive and not appropriate for flight in severe turbulence.

**No attempt should be made to resist or override the AP action by applying a force on the control column**. This would result in the AP disconnection and further upset of the flightpath.

It is worth stressing that the g-loads felt during turbulence are mainly due to the gusts and not due to the AP activity.

In case of an overspeed condition, the procedure for VM0 / Mmo exceedence recovery should be followed. Using the speedbrakes may be considered but their extension may further amplify the g-load variations.

Only if the AP actions are considered unsatisfactory or if a marked exceedence of VM0 / Mmo is experienced, should AP be disconnected and the aircraft be flown manually with smooth control inputs.

**Cabin crew procedures**

An FAA study reveals that most of the serious injuries affecting passengers, walking in the cabin or seated unrestrained by their seat belts, have been experienced after an announcement requiring the passengers to return to their seats and/or fasten their seat belts.

Flight attendants take the greater toll in serious injuries as their crew duties require them to secure cabin and galleys equipment and check passengers before seating and securing themselves.

Without formally considering leaving the Fasten Seat Belt sign ON for the entire flight (which would not fulfill the intended purpose), the authorities are considering stricter rules to enforce the compliance with the cabin announcements and signs. In the meantime, the operators could (or should) lead the way in developing stricter recommendations and procedures to help flight attendants enforce cabin announcements and signs.

**CONCLUSION**

Although areas and severity of turbulence can be quite accurately forecast, unheralded turbulence encounters cannot be totally avoided. Whenever applicable, the product improvements, developed to enhance the aircraft behaviour in turbulence, should be considered for incorporation at the earliest convenient opportunity. The particular nature of flight in severe turbulence and its possible consequences should be highlighted (together with the associated procedures) to flight crews and cabin crews as part of a dedicated awareness of turbulence in general training programmes. By adhering to the above recommendations, a turbulence encounter should remain a normal play but by no means become a thriller.
Choosing an external paint scheme for your aircraft

by Hansjoerg F. SPECHT
Group Manager
Customer Engineering Coordination and Support
Engineering Directorate

For the average man who uses a paint-brush at home from time to time, painting an aircraft may seem a relatively simple affair. He could not be more wrong. The part of the painting sequence which most affects the customer is his choice of paint supplier and decoration of his aircraft, that is, the customized painting requirement. This article, the first in a series on aircraft painting, describes the sequence of events which are necessary to define a customer's paint scheme and paint for his aircraft, and explains why the process may be quite long.
AIRCRAFT PAINTING
THE CUSTOMIZATION TASK

To paint an aircraft, a number of things have to be taken into account such as the image of the airline, the requirements of the Airworthiness Authorities and quality of the paint.

Airline corporate image

The choice of a colour or combination of different colours, is a matter of taste and therefore unpredictable. Symbols or ideograms, created for an airline by artists and designers, are subject to cultural influences, traditions, airline marketing requirements such as easy identification, passenger appeal, and history.

Authority requirements

Mandatory aspects, defined by Airworthiness Authorities are:
- Exterior markings for safety, instruction and identification.
- Environmental aspects such as paint application and paint-stripping procedures.
- Reflectance. JAR and FAR 25.811 require that emergency exits which can be opened from the outside must be clearly marked (reflectance is the fraction of projected light that is reflected from a surface).

Therefore:
- The outside marking for each passenger emergency exit on the side of the fuselage must include a 2-inch coloured band outlining the exit.
- Each outside marking, including the band, must have colour contrast so be readily distinguishable from the surrounding fuselage surface. The contrast must be such that the reflectance of the darker colour is 15%.
- The reflectance of the lighter colour must be at least 45%.

See Figure 1.

Paint quality

Paint quality has to fulfil two main criteria:
- the customer's criteria for acceptance of the painted aircraft at delivery and subsequent service,
- how to meet technical requirements, the most important being:
  - additional surface protection by the paint scheme applied over and above the basic surface treatment of metallic and non-metallic materials,
  - appearance of colours, their brilliance and resistance to ultraviolet light,
  - lifetime of paint scheme to be used,
  - reproducibility of a paint scheme (stripping and repainting).

Figure 1
External marking of passenger exits

<table>
<thead>
<tr>
<th>Reflectance of different colours</th>
<th>White</th>
<th>Grey</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>90%</td>
<td>50%</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>Pale blue</td>
<td>32.86%</td>
<td>90%</td>
<td>57.14%</td>
</tr>
<tr>
<td>Dark blue</td>
<td>5.62%</td>
<td>50%</td>
<td>44.38%</td>
</tr>
</tbody>
</table>
Table 1

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Qualified system</th>
<th>Aircraft type</th>
<th>Standard products (whole aircraft)</th>
<th>Alternate products</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORTAULDS AEROSPACE</td>
<td>Wash-primer: P99 Primer: PAC33 Top coat: PU66</td>
<td>ALL</td>
<td></td>
<td>Applicable on fuselage, vertical stabilizer and nacelles</td>
</tr>
<tr>
<td>CORTAULDS AEROSPACE</td>
<td>Primer: INTERGARD 90 Barrier coat: CA 30 000 UVR(§) top coat: CA 40 000</td>
<td>A319/A320/A321 A330/A340</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DEFINING THE AIRCRAFT LIVERY**

Table 1 shows two different choices of paints and primers for the fuselage and vertical stabilizer, from three different suppliers. An Intermediate/Barrier Coat System to allow easier stripping of the top coat is also approved by Airbus Industrie.

The decorative finish applied to the top coat is of major importance for corporate identity and airworthiness requirements (i.e. buyer’s name and logo, buyer’s ideograms, national flag and shipnames, aircraft registration marks and all exterior markings for safety and advisory instructions). However, the decorative finish is of lesser importance as far as surface and weight repercussion are concerned. Figure 2 shows the typical thicknesses of the paint systems defined in Table 1.

Customers may request that the top coat and decorative surfaces be covered with clearcoat varnish. Table 2 shows the weight effect of different paint and varnish layers.

**Figure 2**

Thickness of different coats (in microns)

- Varnish: 30 to 40µ
- Painted area: 40 to 70µ
- Top coat: 50 to 130µ
- Barrier coat: 8 to 10µ
- Primer: 15 to 25µ
- Wash primer: 6 to 8µ

**Table 2**

<table>
<thead>
<tr>
<th>Paint ref. for fin + fuselage + nacelles</th>
<th>Aircraft</th>
<th>Painted area</th>
<th>Paint mass on A/C</th>
<th>Varnish (*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White BAC 7067</td>
<td>A300-600</td>
<td>1650m²</td>
<td>+ 270kg</td>
<td>Up to 40kg</td>
</tr>
<tr>
<td></td>
<td>A310</td>
<td>1420m²</td>
<td>+ 230kg</td>
<td>Up to 40kg</td>
</tr>
<tr>
<td>White MATTERHORN</td>
<td>A319</td>
<td>815m²</td>
<td>+ 95kg</td>
<td>Up to 20kg</td>
</tr>
<tr>
<td></td>
<td>A320</td>
<td>860m²</td>
<td>+ 100kg</td>
<td>Up to 25kg</td>
</tr>
<tr>
<td></td>
<td>A321</td>
<td>945m²</td>
<td>+ 110kg</td>
<td>Up to 25kg</td>
</tr>
<tr>
<td>White BAC 7067</td>
<td>A319</td>
<td>815m²</td>
<td>+ 110kg</td>
<td>Up to 20kg</td>
</tr>
<tr>
<td></td>
<td>A320</td>
<td>860m²</td>
<td>+ 115kg</td>
<td>Up to 25kg</td>
</tr>
<tr>
<td></td>
<td>A321</td>
<td>945m²</td>
<td>+ 125kg</td>
<td>Up to 25kg</td>
</tr>
<tr>
<td>White MATTERHORN</td>
<td>A330/A340-300</td>
<td>2220m²</td>
<td>+ 270kg</td>
<td>Up to 50kg</td>
</tr>
<tr>
<td></td>
<td>A340-200</td>
<td>2145m²</td>
<td>+ 260kg</td>
<td>Up to 50kg</td>
</tr>
<tr>
<td>White BAC 7067</td>
<td>A330/A340-300</td>
<td>2220m²</td>
<td>+ 330kg</td>
<td>Up to 50kg</td>
</tr>
<tr>
<td></td>
<td>A340-200</td>
<td>2145m²</td>
<td>+ 317kg</td>
<td>Up to 50kg</td>
</tr>
</tbody>
</table>

*Coloured decoration finish: + 2 to 40kg for each paint reference.

(§) Depending on surface coated, partially or total (fin + fuselage + nacelles).
Definition of the Buyer's livery is achieved by using the Request for Change (RFC) and Specification Change Notice (SCN) procedures as defined in the Technical Specification. Perhaps more than one RFC may be needed. Figure 3 shows a typical paint drawing prepared for acceptance by a customer.
AIRCRAFT EXTERNAL DECORATION

Paints are subjected to a very rigorous testing procedure before being accepted. The colours have to be mixed to meet the customer's specification and the paint has to adhere to the primer (undercoat) covering all the structural parts.

If the customer chooses known paints from a known supplier and stays with a conventional aircraft livery (customized fuselage, fin and nacelle) then the procedure is very easy and the leadtime is short.

However if the customer chooses a customized paint scheme for other surfaces, such as the horizontal stabilizer and wings, the leadtime would increase.

In a situation where the paint and the supplier are new to Airbus Industrie, some additional time would have to be added to the predelivery schedule in order to validate the new products for application to the aircraft. The sequence of events is displayed in Figure 4.

MARKING OUT AND ACCEPTANCE OF FIRST AIRCRAFT

The finalization of the initial marking out of the first aircraft, as illustrated in Figure 5, is an important date.
Figure 6
Confirmation of location of template for Chinese character under the wing...

... and position of template

With the customer's acceptance of the external decoration of its first aircraft (i.e. paint scheme and suppliers, colours, registration, shipnames, flag, letter style, ideograms and markings, decals, etc.), the drawings are agreed and perforated templates (pouncings) are prepared to assure commonality of appearance for the subsequent aircraft in the customer's fleet, as shown in Figures 6 and 7.
This acceptance of the external decoration of the customer's first aircraft allows go-ahead for the masking of the complete aircraft and its painting as shown in Figure 8.

CONCLUSION

The acceptance of the painted aircraft on the agreed date is the goal which all the interested parties have been working towards. It is truly an international team effort. Senior airline management, public relations teams both inside and outside the airline, designers and technicians, suppliers, coordinators and inspectors all have to work together to achieve the shortest time scale.
It is one thing to have an idea, but to make that idea work is the real achievement. Such was the case with the Thermal Curtain project. "And today's weather forecast? Well, it will be hot and hazy with temperatures around the average for this time of year, that's 39°C Celsius or 102°F on the Fahrenheit scale. So let's cool the aircraft cabin!" A great idea but how do we achieve it?

For most of us who live and work in an air-conditioned environment the daily summer temperature here in Dubai means little more than a bit of discomfort on our way to and from the office. But with temperatures on average at least 5°C hotter on the airport ramp, the term "summer temperatures" takes on a whole new meaning, not only for the cabin crew and staff involved in the preflight preparation of the aircraft, but even more importantly for the passengers travelling on board.

The ideal situation would of course be to do what everyone else does in the summer... Keep the doors closed! But with constant access to the aircraft required by engineering, catering, cleaning and of course to board passengers, this is neither practical nor possible. Even with the aircraft air-conditioning system working to its optimum, the maximum reduction in temperature is around 4°C, an acceptable but not considerable difference.

Having experienced the discomfort on board the aircraft whilst on the ground in Dubai, the question of how to cool the cabin was constantly with us. Newly implemented cooling tactics included fitting cockpit sunshades, pulling down cabin window blinds and opening fresh air vents, and operating the air-conditioning system for at least two and a half hours prior to departure. This certainly resulted in a reduction in temperature but it was still too hot. Our main problem was that we were wasting the supply of cool air and inadvertently trying to cool Dubai Airport via the aircraft passenger doors.

During a meeting to discuss the subject of aircraft cabin cooling and specifically the loss of cool air and influx of hot air through the cabin doors, it was agreed that what was needed was some type of covering over the passenger doorways. However, the main criteria had to be that this did not interfere with the normal servicing of the aircraft. Eventually a piece of polythene sheeting was draped over the door area, as is the custom in the souk shops, and so the Thermal Curtain was born.

The idea seemed simple enough and we thought that with a little time and effort a method could be devised for hanging the polythene sheet. How wrong we were! Little did we realise what a difficult and long road we would have to travel to produce an effective design. Initial trials using just two pieces of polythene sheet
draped over an adapted shower curtain rail showed a significant lowering of the cabin temperature. Various methods of draping the polythene were tried, with an equal number of problems arising with each! It was now becoming obvious that this "simple" idea was turning into a major project, requiring a number of dedicated personnel.

With each new step taken in the design process, more and more criteria for the curtain’s effective use became apparent. Not only did the curtain need to effectively prevent cool air escaping from the cabin, but it also had to be quick to erect and dismantle both for normal use and in an emergency. It had to be safe and practical for crews and convenient for passengers, and last but by no means least, it had to be aesthetically pleasing and cost effective. A tall order indeed!

It soon became obvious that the original concept would not meet the required criteria effectively. And so back to the drawing board! After a great deal of thought, discussion, trial and error, an aluminium framework was designed to "lock" into the doorway structure. This was then covered with polythene which parted in the centre to provide a practical opening. To make the curtain aesthetically pleasing to passengers and to blend in with the aircraft decor, the Emirates logo in Arabic was printed on the plastic.

Support of the concept from Engineering Management added the necessary encouragement. An initial delay in the full-scale manufacture of the curtain assemblies, due to a heavy workload in Engineering, was at the time frustrating; however, in the end it proved to be a blessing in disguise. The delay gave the design team the opportunity to collect its thoughts and review the design just once more. Feedback from other Emirates departments including Flight Operations, Flight Safety, In-Flight Services, External Relations and Traffic also proved to be invaluable. On reflection the construction was rather cumbersome and therefore not as practical as we would have liked. After more trial and error another design evolved which is basically the one in use today - a lightweight aluminium framework which is contoured to the doorway structure. The new unit has proven to be light and easy to install, and with disciplined use can show as much as 10°C difference between the temperatures in the cabin and outside the aircraft. The Thermal Curtain is installed after the passengers have disembarked and removed just prior to departure, each operation taking about a minute. After eleven months of in-service experience it is now in full production, in-house at Emirates.

The summer of 1994 witnessed its introduction for daytime use. Its popularity amongst the crews was very encouraging and the favourable comments from our passengers even more so. Not only did our crews and passengers enjoy a cooler cabin, but an invisible spin-off became evident; this now cool and friendly cabin had a positive effect upon the electronic systems, which resulted in a reduction of defects and faults compared to previous summers. A further observation from a catering point of view was that the food loaded for the flight retained its freshness due to the cooler environment. Because its effectiveness has been proven, a policy decision was made to fit the Thermal Curtain during day and night turnarounds in the summer of 1995. Manufacture of sufficient units to meet this demand is in progress.

So successful has the project been that Emirates has now commenced the preliminary work to register the Thermal Curtain for patent protection.

The Thermal Curtain Team

Mr. Alby Weimans, Senior Engineer Defect Monitoring, is the principal designer of this Thermal Curtain. The subject units are readily available and will be used across the fleet this summer.

For any further information, please contact Mr. Steve Brown, General Manager Engineering (Aircraft Maintenance) Emirates, PO. Box 6896, Dubai, UAE.
by Colin KANE, Engineer Electrical Systems
Customer Services Directorate

The first article in FAST 14, covered the Ageing Aircraft Electrical Installation Survey initiated by the Customer Support Engineering Team in Airbus Industrie, outlined the aims, set-up, planning, and some initial findings. This article describes how the programme planning was modified with progress through the inspections, the final analysis of the findings and how these will be of benefit to Airbus Industrie and the operators of its aircraft.
Following the analysis of the results of the first and second inspections of the survey, it was decided that the original estimation of up to ten checks was unnecessary. The team then used the findings of the third visit to assess the requirements for the continuation of the programme and were happy to be able to reduce the visits to four. Happy because the findings on the aircraft already seen were building confidence in the A300 B2/B4 installation and also because all the required information was now available.

In early March 1994 an A300B4 aircraft with the necessary requirements of flight hours and operational climatic conditions became available and the team salled forth to carry out the final inspection in the programme. It turned out to be a fortunate choice as the access was practically unrestricted and thus gave us the opportunity to cross-check all the observations made on the previous visits. In the course of the four visits the team actually saw seven aircraft and the details of these are listed in Table 1. With the exception of the major vendor harnesses on powerplants, undercarriage, galleys, and the fuel tank areas, we inspected as much as possible on each aircraft and covered each zone at least twice during the survey.

### STATISTICS

When the inspections were complete the task of analyzing the findings began. For design office use we needed to categorize the observations, and working with a total of over six hundred and fifty, however minor and seemingly trivial, we created two categories, Installation and Equipment. The initial split between Installation and Equipment categories is illustrated in Figure 1 as a percentage of the total.

<table>
<thead>
<tr>
<th>Aircraft checked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>A300B2</td>
</tr>
<tr>
<td>A300B2</td>
</tr>
<tr>
<td>A300B2</td>
</tr>
<tr>
<td>A300B4</td>
</tr>
<tr>
<td>A300B4</td>
</tr>
</tbody>
</table>

**Figure 1**

Sharing out by elements in defect

- Equipment: 28%
- Installation: 72%

*Missing protection and damaged wires at connector backshell*
Now we can look more closely at each category and see how they were broken down into their various elements. Two methods were employed: share of defects and share of parts implicated.

Figure 2 illustrates the share-out of defects as a percentage of the total related to the Installation category. As we can see the most common defects in this group are:
- damage to the harness: 13%
- inadequate protection: 16%
- unsecured mounting: 18%
- chafing: 34%

Figure 3 illustrates the breakdown for the Equipment category but this time showing the percentage of each item in the total. We can see from this example that, of the items listed, clamps compose the highest percentage of the defects by a large margin over the others.

**AIRCRAFT IMPROVEMENTS**

Following on from the general statistical analysis we looked at the defects in relation to aircraft zones and areas. From this data we can identify where we have to make changes to the installation, equipment, procedures or documentation. Some of the defects had also been identified in the past from operator reports and subsequently had fixes in place and these are included in Table 2. Some items are still under study.

**TRAINING**

In addition to the ageing effect on the items already described it is important to point out the immense effect that maintenance has on the wiring installation. Operators must be aware that the consequences of neglect or perfunctory repairs are needless system faults. A mechanic working on mixed-manufacturer fleets of aircraft does not always appreciate the differing technologies employed in terms of materials and processes and so sometimes carries out repairs to suit his toolbox instead of the installation. With this in mind we are looking at the need for an in-house training programme to heighten awareness of operators and give sound guidelines for basic installation procedures.

**DOCUMENTATION**

Changes to the Electrical Standard Practices of the Aircraft Wiring Lists/Manual Chapter 20 will be introduced progressively, starting with a revision of the wire repair procedures. Talking to airline maintenance personnel and seeing the varied repairs carried out reinforced the impression that procedures and selection of materials such as splices and sleeves could be simplified. The complete section will be reissued with clear instructions for each potential situation.
## Table 2

<table>
<thead>
<tr>
<th>Defects</th>
<th>Fixes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chafing of wires under NSA5515 nylon clamps due to vibration and movement.</td>
<td>Inspection SB24-073 Issued Jun 86 Rev 2 Sept 90. This SB recommends inspection of the wiring and replacement of clamps with NSA5516 standard. The NSA5515 clamps are no longer used for new designs.</td>
</tr>
<tr>
<td>Degradation of wires at the wing trailing edge to fuselage interface. This zone, at the No.1 flap screwjack, is difficult for wiring, with wing flexing, grease, hydraulic fluids, and general swamp conditions.</td>
<td>Inspection SRB4-085(A300-600SRB24-6043). Inspection, protection and improved clamping of the harnesses across the area.</td>
</tr>
<tr>
<td>Cable ties become brittle and snap in hot areas such as avionic bay power centres.</td>
<td>New materials under study.</td>
</tr>
<tr>
<td>Clamps of different types display different problems:</td>
<td></td>
</tr>
<tr>
<td>- NSA5516 clamps of all types break due to corrosion.</td>
<td></td>
</tr>
<tr>
<td>- NSA5516NV (Viton) clamps degrade due to hydraulic fluid.</td>
<td></td>
</tr>
<tr>
<td>Shrink conduit. In areas where the conduit is in movement it can become brittle and break.</td>
<td>For new projects the design of moving harnesses will be reviewed.</td>
</tr>
<tr>
<td>Shrink conduit (Viton). As with the Viton clamps this material does not withstand contamination with hydraulic fluid in the long term. It will deform and possibly split.</td>
<td>Will not be used for new designs in areas where hydraulic fluid contamination is possible or likely.</td>
</tr>
<tr>
<td>Convoluted PTFE conduit. Chafing is evident in vibration areas such as the engine pylons.</td>
<td>For in-service aircraft A300 SB24-078 (A310 SB24-2044 A300-600 SB24-6035) is available to replace conduits in some pylon areas. For future projects the design of the installation will be reviewed.</td>
</tr>
<tr>
<td>Ground points. Blue varnish degrades and flakes off. Some ground points in this condition were subjected to resistance checks and were found to be still well within the specified limits.</td>
<td>New varnish materials are being studied.</td>
</tr>
<tr>
<td>Equipment identification labels. With time, labels which are stuck on structure and which have been contaminated by hydraulic fluid become illegible or are lost.</td>
<td>Product and process to be improved for future projects.</td>
</tr>
<tr>
<td>Connector identification sleeves. With age and hydraulic fluid contamination, the printing can be obliterated or faded.</td>
<td>New materials and processes under review.</td>
</tr>
</tbody>
</table>

and rationalization of materials to reduce cost and eliminate confusion. In addition there will be advice on protection of harnesses when such a need is identified. This revision is in the process of checking and approval but is targeted to be in the documentation for all Airbus aircraft types before the end of 1995. The introduction to the Zonal Inspection section of the A300 Maintenance Planning Document will be revised to clarify that the electrical installation, along with other systems, should be visually inspected for proper attachment and security with the zonal checks.

## CONCLUSION

Once again it is important to note that most of the defects observed during the survey were of a minor nature. Airbus Industrie is confident in the general integrity of the A300 electrical installation which was found to be resistant to ageing, with operators apparently maintaining this satisfactory condition. However, we have identified areas where improvements can and will be made both for the A300 and our newer aircraft types.

The study of the A300 also highlighted the need to do this type of review on other Airbus Industrie aircraft types. Changes in technology and materials mean that the A310, while having the same basic design philosophy as the A300, has a very different installation. To maintain the knowledge base for Customer Support Engineering we intend to carry out similar inspections on two early A310 aircraft and planning for this will begin at the end of this summer.

One other important conclusion reached during the planning and execution of the A300 survey was that operators are interested in the improvement programme, and Airbus Industrie and the operators have a common interest in that process. The Customer Support Engineering team are very grateful for all the offers of aircraft for the survey, and for the keen interest, assistance and hospitality received from those airlines which they were lucky enough to visit.
T
ehe TPCI is an interrogation tool which enables a person to consult a single data bank containing the cross-references and links between the following Airbus Industrie documents:
- Modification (MOD)
- Modification Proposal (MP)
- Service Bulletin (SB)
- Vendor Service Bulletin (VSB)
- Service Information Letter (SIL)
- Technical Follow-up (TFU)
- All Operators Telex (AOT)
- Operator Information Telex (OIT)
- Operations Engineering Bulletin (OEB)
- Airworthiness Directive (AD)
- Consigne de Navigabilité (CN) (the French AD).

This article describes in some detail the following main areas of interest:
- the available media,
- the contents of the TPCI, including an overview of the selection criteria for each of the above mentioned documents,
- the recommended hardware and software requirements,
- the issue and revision service,
- navigation through the TPCI, showing two typical types of search.

Airbus Industrie and a group of airlines worked together from the beginning of the project to define the requirements for media and contents.

Whilst the terms of the MOD, MP, SB, VSB, SIL, AD and/or CN are generally well known to the users, it is appropriate to recall briefly the main objectives of the TFU, AOT, OIT, and OEB.

- **Technical Follow-up**

The TFU is an engineering oriented one-page synthesis issued for each identified in-service event from the flight-test line through in-service operation. The basic goal of the TFU is to be a communication system which allows all operators to acquire the necessary information on the actions and means developed by Airbus Industrie to fix the technical is-
issues linked to the in-service event.

- **All Operators Telex**
The AOT is issued by Airbus Industrie any time an incident or in-service finding with potential safety implications is reported to Airbus Industrie by an operator which leads to a **fleetwide action** to be taken by the operators within a specified time frame.

- **Operator Information Telex**
The OIT is issued to convey information on safety related in-service events, but for which **no action** is required by the operators. An OIT is also issued to convey general information on maintenance or operations related events which need to be brought to the attention of the operators quickly.

- **Operations Engineering Bulletin**
The OEB is a temporary means of conveying technical and/or procedural information having an operational impact, pending either application of an Airbus Industrie SB, or an update of the operational documentation such as the Flight Crew Operating Manual, when a decision has been taken not to modify the aircraft. Red OEBs are issued when the subject has been identified as having a significant impact on the operation of the aircraft.

### MEDIA

At the beginning of 1994, a general survey took place with a large group of Airbus operators to identify the on-site users' expectations in terms of content and deliverable media. The conclusion was unanimously in favour of digital format which was recognized as the best means to store and manage the TPCI information down to the necessary level, with increased efficiency. The TPCI is provided on 3.5" diskettes and/or on CD-ROM (at the user's choice) and the retrieval software runs on an IBM PC AT compatible computer, in the MS-DOS and Windows environment.

### CONTENTS

The contents of the TPCI are a series of selection criteria for each document type. Access is available from any of these elements (see Table 1) and all the cross-references between them have been inserted.

For all document types, the selection criteria used for a query are the elements 1 to 6. The TPCI will display, as applicable, the **complete index information**, of the source document (elements 1 to 5 and 7 to 12), and **all links** (e.g. MOD, TFU, OEB...) to that source document.

Each of the selection criteria is an entry point to find cross-references with the other document types.

Depending upon the nature of the selection criteria taken by the TPCI user for the document type, which is the starting point of the query, the TPCI will provide step by step all necessary level of cross-references (Two examples of search are displayed in the following pages).

### HARDWARE AND SOFTWARE REQUIREMENTS

The minimum computer configuration needed to run the TPCI is the following:

- An IBM PC AT compatible compute in MS DOS or Windows environment (486 recommended).
- 400 kB of available memory.
- A 3.5" diskette drive.
- A CD-ROM drive (if TPCI is installed from a CD-ROM).
- Sufficient hard disk space (5 to 10 MB) to store the TPCI data for different aircraft types (if TPCI is installed from a diskette).

### DISTRIBUTION

Prior to the issue of the TPCI, a person searching for cross reference information had to search through a large quantity of paper indexes each with a different layout. These indexes: the SB index, SIL index, list of modifications sorted by ATA chapter, SB/MOD cross-reference list, VSB status, AOT/OIT index will become obsolete in the near future and will be replaced by the TPCI:

- on CD-ROM, for stations equipped with CD-ROM drives, or
- on 3.5" diskettes which may be replaced by CD-ROM later, on the operator's request.

The diskettes are issued per aircraft type applicable to the operator's fleet. For CD-ROM, the operators are provided with an access code relative to the Airbus type(s) they operate.

Revisions of the TPCI will be issued **monthly** in the same quantities as the SE index already given to each operator.

### Table 1

<table>
<thead>
<tr>
<th>Selection criteria for each document type.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The aircraft type (e.g. A340).</td>
</tr>
<tr>
<td>2. The document type (e.g. SB).</td>
</tr>
<tr>
<td>3. The document reference (e.g. 78-1011).</td>
</tr>
<tr>
<td>4. The ATA reference (two or more digits).</td>
</tr>
<tr>
<td>5. The title/subject, in full words or only a portion of title and/or keywords e.g. cabin comfort.</td>
</tr>
<tr>
<td>6. The month/year. From... to... (for query only).</td>
</tr>
<tr>
<td>7. The original issue date.</td>
</tr>
<tr>
<td>8. The last revision date/revision number.</td>
</tr>
<tr>
<td>9. The vendor code/vendor name (for VSB).</td>
</tr>
<tr>
<td>10. The airline code effectiveness (for SBs and OEB).</td>
</tr>
<tr>
<td>11. The application date/cancellation reason (for ADs and CN).</td>
</tr>
<tr>
<td>12. The status:</td>
</tr>
<tr>
<td>• cancelled/open for SIL,</td>
</tr>
<tr>
<td>• open/closed/abeyance/cancelled for TFU,</td>
</tr>
<tr>
<td>• open/closed/cancelled for AOT.</td>
</tr>
</tbody>
</table>
EXAMPLES OF QUERY AND DOCUMENT SELECTION SCREEN

SIMPLE ACCESS THROUGH ONE REFERENCE

1. Query screen/selection criteria input

   OIT selected

2. Access to the document definition screen and display of all available links

   OIT page appears
   Link to TFU is selected

3. Access to the links by selecting one document type.
   There are two cases:
   • If only one link (one reference):
     Direct access to the screen defining that document

   TFU page appears
   Link to SB is selected

• If several references are identified:
  The screen will display the list of all linked references.

Note: By selecting any of these references, the TPCI will display the index characteristics of the selected document as shown in reference 2 above.
MORE COMPLEX ACCESS

Query screen/selection criteria input
This screen displays a query for A320 documents of SB, TFU, OEB, SIL, AOT and/or MOD type, relative to ATA21, for which the title contains the keywords (or part of keywords) Cabin and Press.

Note: An advantage of the TPCI is that it allows the use of abbreviated keywords such as Press or the equivalent full keywords Pressure or Pressurization.

Display of the list of all links
The list displays various types of documents.

TFU is selected

One of these documents is selected to access the screen which displays its index characteristics/definition.

Selected TFU appears

Tapping the Back key allows the operator to move back to previous screen displays.

CONCLUSION

Establishing the effective links between all the paper indexes was undoubtedly a time consuming event. The TPCI, as a stand alone software, now offers simple and efficient access to a multitude of selection criteria and index links between document types for which there were, until now, only partial or no immediate links available. These advantages, one unique data source in digital format, quick access, user-friendliness and monthly updating, will result in a considerable time saving and improved efficiency for all TPCI users in the Airbus airline environment.
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## Location | Country | Telephone | Telefax | Sita
---|---|---|---|---
Abu Dhabi | United Arab Emirates | 971 (2) 206 7702 | 971 (2) 205 967 | ADEALY
Aden | Yemen | 967 (2) 233 3888 | 967 (2) 222 855 | AMMBUY
Amman | Jordan | 962 (7) 212 0761 | 962 (7) 212 104 | ATHEYO
Athens | Greece | 30 (2) 98 1551 | 30 (2) 98 32479 | BAHEFGL
Atlanta (Georgia) | USA | 1 (404) 762 0011 | 1 (404) 762 7501 | BKKZUTG
Bahrain | Bahrain | 973 327 262 | 973 320 584 | BOMPC
Bangkok | Thailand | 66 (2) 531 0076 | 66 (2) 531 1940 | BOMFD
Bombay | India | 91 (22) 662 8214 | 91 (22) 611 3561 | BOMFD
Bucharest | Romania | 40 (2) 400 250 | 40 (2) 312 5555 | BULDTR
Buenos Aires | Argentina | 54 (1) 480 9409 | 54 (1) 480 9409 | CAIESMS
Cairo | Egypt | 20 218 368 | 20 218 3705 | CAIESMS
Chicago | USA (Illinois) | 312 (2) 645 4602 | 312 (2) 645 4602 | CMBF
Colombo | Sri Lanka | 94 (7) 217 579 | 94 (7) 534 809 | DKB
Copenhagen | Denmark | 45 (2) 247 7279 | 45 (2) 247 7279 | CBH
Dakar | Senegal | 221 201 615 | 221 201 148 | DRKB
Delhi | India | 91 (11) 565 2033 | 91 (11) 565 2033 | DKB
Dubai | United Arab Emirates | 971 (4) 822 819 | 971 (4) 822 819 | DESEL
Dublin | Ireland | 353 (1) 705 2924 | 353 (1) 705 3803 | DUSEL
Dusseldorf | Germany | 49 (2) 9 86 8678 | 49 (2) 9 86 8678 | DUSS
Frankfurt | Germany | 49 (69) 696 9947 | 49 (69) 696 9947 | DUSS
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Heraklion | Greece | 30 (811) 330 540 | 30 (811) 330 540 | ERS
Ho Chi Minh City | Viet Nam | 84 (8) 905 965 | 84 (8) 446 419 | HCM
Hong Kong | Hong Kong | 852 747 8449 | 852 747 8449 | HK
Houston | USA (Texas) | 1 (713) 985 3623 | 1 (713) 985 3624 | KUL
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Kuwait | Kuwait | 965 347 2191 | 965 347 2191 | KUL
Larnaca | Cyprus | 357 (2) 643 181 | 357 (2) 643 185 | LCAB
Lisbon | Portugal | 351 (1) 807 032 | 351 (1) 847 4444 | LIS
London (LHR) | England | 44 (181) 751 5431 | 44 (181) 751 2844 | LGB
Los Angeles | USA (California) | 1 (310) 348 0991 | 1 (310) 348 8755 | LON
Luton | England | 44 (158) 239 8706 | 44 (158) 248 3826 | LON
Madrid | Spain | 34 (1) 329 1447 | 34 (1) 329 0708 | LON

## Notes
- The numbers provided are direct dialing codes and should be used for international calls.
- SITA codes are used for airline reservations and ticketing purposes.
- The representation covers a wide range of countries, indicating the presence of Airbus support services worldwide.
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Turbulent Flight - Part 2

Flying today is relatively peaceful and predictable. It was not always so and in the beginning of manned flight some would-be aviators chose particularly turbulent paths to investigate. Some thought that if other creatures can fly by flapping wings then man should be able to also.

One of them was Mr. Pompeien Piraud, but he had come to the conclusion that copying the chiroptera (bat) family was most likely to lead to success. So in 1879 he built a flapping wing machine powered by a steam engine which exploded. He was not put off by this temporary setback and continued his experiments into the 1880s but with the same lack of success, perhaps fortunately!

Chiroptera, from the Greek, "kheir" hand and "pteran" wing.

Flying machine with articulating wings designed by Pompeien Piraud in 1882.
THE A330 IS THE MOST EFFICIENT JETLINER EVER DESIGNED.

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Typically accommodates 335 passengers (2-class) in true widebody comfort. Up to 440 seats in high-density arrangement.

Uncompromised design gives lowest weight, lowest fuel consumption, lowest maintenance costs, lowest operating costs.

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There is no such thing as an Airbus. Each of the seven distinctly different Airbus Industrie aircraft is individually designed to offer unique benefits and to meet the specific needs of operators.